The Total Risk Integrated Methodology (TRIM):

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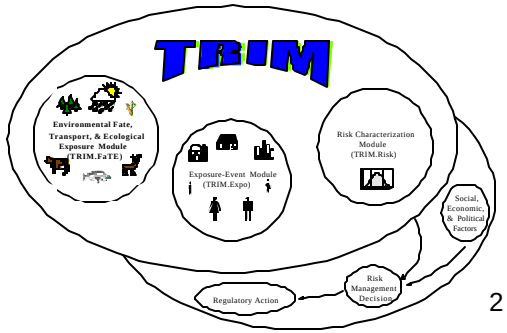
TRIM is intended to:

- Provide a modeling system for assessing air pollutants that addresses:
  - **human health** and **ecological risk**;
  - single or multimedia, multipathway exposure;
  - multiple pollutants (e.g., mixtures, transformation products);
  - quantitative uncertainty and variability;
- AND meet the needs of both the **hazardous & criteria** air pollutant programs.



TRIM has Three Modules (see Figure 1)

- **Fate, Transport & Ecological Exposure Module (TRIM.FaTE) ..**
  - is a time series mass balance model that accounts for the movement of a chemical(s) through a system of discrete compartments (e.g., media, biota) representing possible locations in the physical and biological environments of the modeled ecosystem.
  - is intended for air pollutants with important non-inhalation exposures.
  - generates both media concentrations relevant to human pollutant exposures and exposure estimates relevant to ecological risk assessment.
- **Exposure Event Module (TRIM.Expo) ...**
  - Assesses human exposures by tracking the activities of population groups and their inhalation and ingestion through time and space.
  - Can receive input from TRIM.FaTE or air quality models or monitoring data.
- **Risk Characterization Module (TRIM.Risk) ...**
  - Calculates human health and ecological risk metrics.
  - Documents model inputs & assumptions.
  - Displays results.

placeholder for TRIM Figure 1

TRIM's Modular Design provides Flexibility

- **In development:**
  - Modules are being developed in a phased approach, with refinements being made as scientific information and tools become available.
- **In application:**
  - The user will be able to select any one or more of these modules for an assessment depending on the user's needs.
    - When performing a human health risk assessment for an air pollutant for which multimedia distribution is not significant, TRIM.Expo may be applied using ambient concentration data or the output from an air quality model external to TRIM. The output from TRIM.Expo may then be used as input to TRIM.Risk to perform the desired risk analyses.
    - In the case of a multimedia air pollutant, such as mercury, the user may choose to run all three TRIM modules to assess both human and ecological risks posed by multipathway exposures from multiple media.

Key Characteristics

TRIM.FaTE:

- **Truly coupled multimedia model** with **feedback loops and secondary pollutant movement**.
- **Conservation of mass**
- Pollutant transfer among **multiple media;** exposure via **multiple pathways.**
- **Transparent approach** in accessible algorithm and input value library.
- **Flexibility of spatial scale, temporal scale and time step** (input and output), as well as in the definition of compartments and linkages.
- **Ability to characterize parameter uncertainty and variability**

TRIM.Expo:

- Simulates movements of an individual or cohorts via **activity patterns** through **microenvironments** in exposure districts.
- Inhalation exposure estimation via **APEX**1 or **HAPEM**4

Outputs of TRIM are useful for ...

- **Human Health risk assessment:**
  - TRIM.FaTE:
    - concentrations in abiotic environmental media
    - concentrations in biota
  - TRIM.Expo:
    - human exposure estimates
  - TRIM.Risk:
    - human risk characterization metrics
- **Ecological Risk Assessment:**
  - TRIM.FaTE:
    - concentrations in abiotic environmental media,
    - concentrations in biota
    - doses to biota
  - TRIM.Risk:
    - ecological risk characterization metrics

TRIM Progress to date includes ...

- **Computer framework** (JAVA) compatible with Windows or UNIX environment, containing TRIM.FaTE and TRIM.Expo.
  - **TRIM.FaTE**, Vers 1 (including sensitivity analysis feature), with algorithms describing multimedia transfers of PAHs and mercury species among biotic and abiotic compartments in example Northeast and Northwest ecosystems.
  - **TRIM.Expo**, inhalation only version, includes APEX1 & HAPEM4 exposure models.
- Prototype for MonteCarlo **uncertainty & variability** analysis feature.
- Conceptual plans & design criteria for TRIM.Expo(ingestion), TRIM.Risk.

Future Development Activities

- **Nearer Term:**
  - Series **TRIM.FaTE** model evaluation activities, including test applications involving Hg and PAH emissions sources. Model and input refinements in response to evaluation findings.
  - Initial test applications of **TRIM.Expo** inhalation models
  - Incorporation of ingestion pathway into **TRIM.Expo**.
  - Development of **TRIM.Risk** module.
  - **User's guidance** document.
- **Farther Term:**
  - Continued **refinement, applications and evaluation** of all modules and computer framework

TRIM Applications

- **Nearer Term**
  - Residual Risk Assessments
    - Multimedia modeling - TRIM.FaTE to augment current capability (e.g., IEM/MPE/HHRAP)
    - Human exposure modeling - phase in TRIM.Expo for inhalation, followed by ingestion (as available)
    - Risk analyses - TRIM.Risk
    - Uncertainty & variability analysis - TRIM to improve current capabilities
  - NAAQS Risk Assessment-ozone review
    - human exposure modeling -TRIM.Expo to augment/improve capability
- **Farther Term:**
  - Residual Risk and NAAQS Risk Assessments; and
  - Integrated Urban Air Toxics Strategy, case-study cities
  - HAP & Source Category Delisting/Listing Analyses
  - Special Studies of Hg & Atmospheric Deposition to Waterbodies

TRIM.FaTE Modeling System

- TRIM.FaTE relies on a system of parcels, volume elements and compartments of various type. [See Figure 2]
  - **Parcels** are planar geographical areas used to subdivide the modeling region.
  - **Volume elements** are bounded 3-dimensional spaces that define the location of one or more compartments.
  - **Compartments** are spatial units within which it is assumed that chemical is homogeneously distributed.
    - **Abiotic** compartment types include, air, surface water, sediment, soil (surface, root zone , vadose zone), and ground water.
    - **Biotic** compartment types include several trophic groups of terrestrial and aquatic wildlife, such as birds, mammals, fish, terrestrial plants (leaf, root, stem), soil invertebrates, benthic invertebrates, algae and aquatic macrophytes. These trophic groups can be modeled relying on input values for representative species.

placeholder for TRIM Figure 2

TRIM.FaTE - Important Characteristics

- Performance as a **truly coupled multimedia model** rather than a set of linked single medium models, with the functionality to account for **feedback loops and secondary pollutant movement**.
- **Conservation of mass,** accounting for all of the pollutant as it moves among the environmental compartments of the system being assessed.
- Transfer of pollutants among **multiple media** and exposure of biota via **multiple pathways.**
- A **transparent approach** for chemical mass transfer and transformation is embodied in an easily accessible algorithm and input value library.
- **Flexibility of spatial scale, temporal scale and time step** (input and output), as well as in the definition of compartments and linkages.
- **Ability to characterize parameter uncertainty and variability,** including both sensitivity and Monte Carlo analyses, allowing critical parameters to be identified and varied to produce distributions of predicted media concentrations for assessing exposure and risk.

TRIM Development is a ...

- Collaborative effort between
  EPA's Office of Air Quality Planning & Standards
  - TRIM.FaTE - Deirdre Murphy
  - TRIM.Expo - Ted Palma, Harvey Richmond, Amy Vasu
  - TRIM.Risk - Terri Nelson

- AND
  - EPA's Office of Research & Development,
  - Lawrence Berkeley National Laboratory,
  - Oak Ridge National Laboratory,
  - University of Tennessee,
  - ICF Consulting,
  - MCNC-North Carolina Supercomputing Center,